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MACROINVERTEBRATE FAUNA ASSOCIATED WITH NATURAL POPULATIONS OF MEDITERRANEAN MUSSEL *(MYTILUS GALLOPROVINCIALIS* LAMARCK, 1819) IN LIM CHANNEL, ISTRA

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ABSTRACT

The macroinvertebrate fauna associated with Mytilus galloprovincialis *Lmk. in the intertidal rocky shore in the Lim Channel, Istra is reported. Ninety two species from eleven phyla were recorded in samples taken during April - October 1994. In terms of species richness the community was dominated by the molluscs (42 species), polychetes (21 spp.) and arthropods (12 spp.), representing 81.4% of the total associated fauna. In terms of abundance the dominant species among the mussel shells (epibiont) was barnacle* Balanus perforatus *Bruguiere, while small brooding bivalve* Lasaea rubra *Montagu dominated amongst the byssal threads.*

Key words: mediterranean mussel, *Mytilus galloprovincialis*, macrofauna, epibionts, infauna, community structure
Ključne besede: užitna klapavica, *Mytilus galloprovincialis*, makrofavna, epibionti, infavna, sestava združbe

INTRODUCTION

Mediterranean mussel *(Mytilus galloprovincialis)* often occupies lower intertidal and infralitoral fringe of rocky shore, especially on moderately wave-exposed sites and areas with slightly lower salinity and abundance of suspended organic matter, that is: eutrophized water and even heavilly polluted harbours (Bellan-Santini, 1969). Mussels attach firmly to the substrate by means of byssal threads and form high density assemblages (Okamura, 1986; Lintas & Seed, 1994). Within interstices of mussel clump (matrix), the accumulated sediment, mussel faeces and pseudofaeces, living and dead mussel shells create "infralitoral micro-niches" that offer certain degree of protection from wave-action and higher humidity to infralitoral organisms with restricted tolerances (Bellan-Santini, 1969; Suchanek, 1985). So, mussel clumps develop into structurally complex entities which provide refuge and habitat for wide variety of associated organisms (Ong-Che & Morton, 1994). But, for a number of sedentary and hemi-sesile organisms (e.g. barnacles, limpets) from intertidal and infralitoral fringe, the mussel shells represent only "secondary space" (Dayton, 1971) for settlement due to intensive competition for available space.

Previous research in the Lim Channel documented midlitoral and upper infralitoral rocky shore communities (Poropat, 1979), natural populations of bivalves, including mussels (Zahtila, 1987) and study on biofouling on the shells of living mussels (Igić, 1975).

STUDIED AREA

Lim Channel is a long bay (11 km), morphologically similar to a fjord. It is situated on the west coast of the Istrian Peninsula, between Rovinj and Poreč, extending from east to west. Minimal sea water temperature (March) is about 10°C and maximum (August) some 24°C. During autumn and winter heavy rains wash the ground from the coast into the sea. Suspended mud particles cause decrease in water transparency, but this also represents abundant input of organic matter. At the head of the Channel several permanent fresh-water springs cause periodical decrease in surface salinity (correlated with tidal rhythm) which influence midlitoral communities (Marinković-Roje, 1958).

MATERIALS AND METHODS

In the Lim Channel mussels form almost intermittent belt in the intertidal zone (average height 0.4 m) and infralitoral fringe. Samples were collected during April - October 1994 at 14 stations (Fig. 1). The sampling unit was a 25x25 cm square with the most homogenous mussel cover of the substrate. The entire square was covered with nylon bag to prevent mobile forms escaping and infaunal organisms washed off through wave-action and then carefully scraped from substrate by a blunt knife (Bellan-Santini, 1969). Samples were preserved in 4% neutral formalin. Some organisms were identified only to higher taxonomic categories (e.g. class, phyla) and treated as single entities.

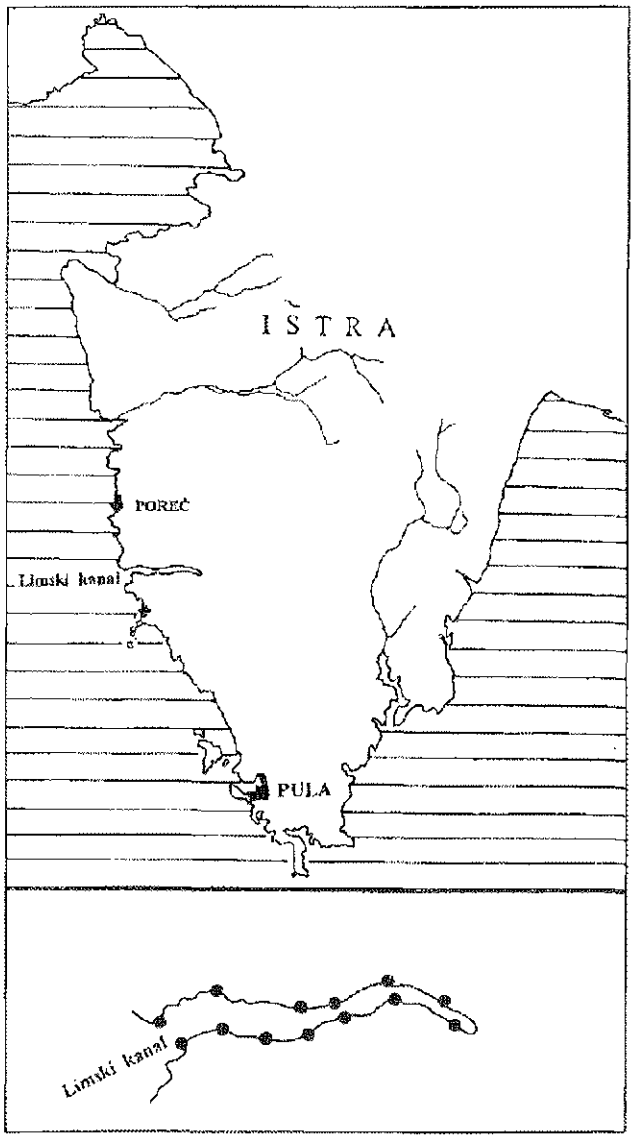

Fig. 1: Study area (top) and sampling stations in the Lim Channel (below).
Slika 1: Zemljevid obravnavanega območja (zgoraj) in vzorčevalne postaje v Limskem kanalu (spodaj).

RESULTS AND DISCUSSION

In samples taken in April and October 1994, a total of 91 species from 11 phyla were recorded (Table 1). The most abundant phyla in terms of species richness were the molluscs (41 species), Annelida (21 spp.) and arthropods (12 spp.)

Phyla	April	October	Total
Porifera	2	2	2
Cnidaria	2	1	2
Platyhelminthes	1	1	1
Sipuncula	1	2	2
Nemertina		1	1
Mollusca	38	33	41
Annelida	18	20	21
Arthropoda	10	9	12
Bryozoa	1	1	1
Echinodermata	4	4	4
Tunicata	1	3	4
Total	79	77	91

Table 1: Faunal composition of the associated fauna.
Tabela 1: Favnistična sestava združbe.

The biota associated with mussels (Fig. 2) can be generally divided into three functional groups (according to Suchanek, 1985):

epibionts - organisms which grow on mussel shells themselves, e.g. barnacles *(Balanus* spp., *Chthamalus stellatus)*, ascidians, bryozoans, oysters *(Ostrea edulis)*

mobile fauna - move freely throughout the matrix and are represented by small crustaceans and free-roving gastropods (juvenile *Gibbula* spp., *Monodonta* spp., *Alvania cimex, Odostomia scalaris)*

infaunal taxa - typically restricted to, and often dependent upon the organic rich sediment and comprise organisms that are more typical of soft sediment environment e.g. polychetes *(Cirriformia tentaculata)*, small ophiurids *(Amphipholis squamata)*, sipunculans *(Aspidosiphon kovalevskii)*.

Ong-Che & Morton (1992) add the fourth category - **small bivalves** in the mass of mussel byssal threads *(Lasaea rubra, Musculus costulatus, Cardita calyculata, Hiatella arctica)*.

PORIFERA
Cliona celata Grant, 1826
Cliona viridis Schmidt, 1898

CNIDARIA
Actinia equina (Linnaeus, 1766)
Balanophyllia europaea (Risso, 1826)

PLATYHELMINTHES
Turbellaria indet.

SIPUNCULA
Aspidosiphon kovalevskii (Murina, 1964)
Phascolosoma granulatum (Leuckart, 1828)

NEMERTINA
Nemertina indet.

MOLLUSCA
Acanthochitona communis (Risso, 1826)
Acanthochitona fascicularis (Linnaeus, 1767)
Lepidochitona corrugata (Reeve, 1848)
Alvania cimex Linnaeus, 1758
Alvania discors (Allan, 1818)
Bittium reticulatum (Da Costa, 1778)
Diodora italica (De France, 1820)
Ealonina cossurae (Calcara, 1841)
Gibbula divaricata (Linnaeus, 1758)
Gibbula racketti (Payraudeau, 1826)
Gibbula rarilineata (Michaud, 1829)
Gibbula varia (Linnaeus, 1758)
Hexaplex trunculus (Linnaeus, 1758)
Littorina neritoides (Linnaeus, 1758)
Monodonta articulata Lamarck, 1822
Monodonta mutabilis (Philippi, 1846)
Monodonta turbinata (Born, 1778)
Nassarius incrassatus (Strom, 1768)
Odostomia scalaris MacGillivray, 1843
Ovatella myosotis (Draparnaud, 1801)
Patella caerulea s. lat.
Runcina sp. 1 cf. *adriatica* (Thompson, 1981)
Runcina sp. 2
Vermetus triqueter Bivona, 1832
Anomia ephippium (Linnaeus, 1758)
Arca noae Linnaeus, 1758
Cardita calyculata (Linnaeus, 1758)
Chama gryphoides Linnaeus, 1758
Gastrochaena dubia (Pennant, 1777)
Hiatella arctica (Linnaeus, 1767)
Hiatella rugosa (Pennant, 1767)
Irus irus (Linnaeus, 1758)
Lasaea rubra (Montagu, 1808)
Modiolus barbatus (Linnaeus, 1758)
Musculus costulatus (Risso, 1826)
Mytilaster minimus (Poli, 1795)
Ostrea edulis Linnaeus, 1758
Ostreola parenzani Settepasi, 1978
Petricola substriatula (Montagu, 1808)
Petricola sp.
Ruditapes decussatus (Linnaeus, 1758)

ANNELIDA
Amphitrides gracilis (Grube, 1860)
Ceratonereis costae (Grube, 1860)
Cirriformia tentaculata (Montagu, 1865)
Fabricia sabella adriatica Banse, 1956
Lepidonotus clava (Montagu, 1808)
Lumbrineris funchalensis (Kinberg, 1865)
Lumbrineris impatiens (Claparede, 1868)
Lysidice ninetta Audouin & Milne-Edwards, 1833
Nereis zonata Malmgren, 1867
Nereis sp.
Notophyllum foliosum (Sars, 1835)
Mystides limbata Saint-Joseph, 1888
Perinereis cultrifera (Grube, 1840)
Phyllodoce maculata (Linnaeus, 1767)
Serpula sp.
Spirorbis sp.
Syllis gracilis Grube, 1840
Terebella lapidaria Linnaeus, 1767
Typosyllis krohnii (Ehlers, 1864)
Vermiliopsis infundibulum (Philippi, 1844)

ARTHROPODA
Balanus amphitrite Darwin, 1854
Balanus eburneus Gould, 1841
Balanus perforatus Bruguiere, 1789
Balanus trigonus Darwin, 1854
Chthamalus stellatus (Poli, 1791)
Pachygrapsus marmoratus (Fabricius, 1787)
Pinnotheres pinnotheres (Linnaeus, 1758)
Pinnotheres pisum (Linnaeus, 1767)
Porcellana platycheles (Pennant, 1777)
Ligia italica Fabricius, 1837
Amphipoda indet.
Isopoda indet.

BRYOZOA
Bryozoa indet.

ECHINODERMATA
Coscinasterias tenuispina (Lamarck, 1816)
Amphipholis squamata (Delle Chiaje, 1828)
Ophiothrix fragilis (Abildgaard, 1789)
Paracentrotus lividus (Lamarck, 1816)

TUNICATA
Botryllus schlosseri Pallas, 1774
Styela plicata (Leseueur, 1823)
Tunicata indet. 1
Tunicata indet. 2

Table 2: List of species recorded from the M. galloprovincialis community in the Lim Channel in April and October 1994.
Tabela 2: Seznam vrst, ugotovljenih v združbi z M. galloprovincialis v Limskem kanalu aprila in oktobra 1994.

Before any further analysis it should be underlined that a number of species reported in Table 2 normally occupy the supralitoral, midlitoral and/or infralitoral fringe, e.g. crustaceans *Ligia italica* and *Pachygrapsus marmoratus* and gastropods *Patella* spp. and that they are not dependent upon mussel community. However, juvenile specimens of topshells *(Monodonta* spp., *Gibbula* spp.), limpets *(Patella* spp.) and also sea-anemones *(Actinia equina)* may find protection from desiccation and overheating within mussel clumps (Poropat, 1979; pers. observ.).

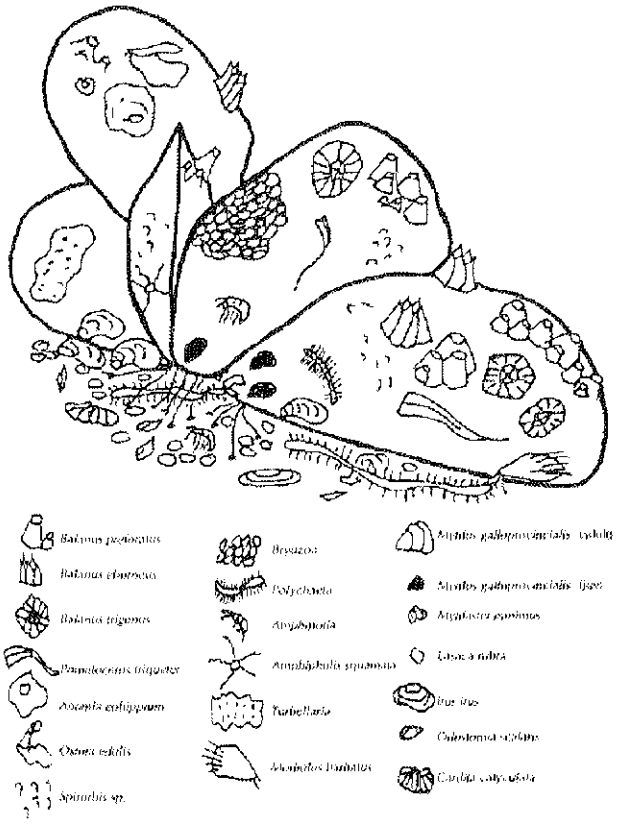

Figure 2: Structure of the mussel community.
Slika 2: Sestava združbe z užitno klapavico.

Some species which occurred only once or were represented only by a few specimens can be regarded as accidental or transient members of the mussel community. According to Zavodnik (1970), the so-called "strange elements" can enter the community ***passively*** carried by currents and waves during larval stage and ***actively*** searching for food or adequate reproduction ground. In our research a few specimens of *Ruditapes decussatus* were found buried in mud and shell debris trapped by byssal threads. It is obvious that the larva somehow managed to survive in this habitat, rocky intertidal transformed through development of the mussel bed. On the other hand, reported whelk *Hexaplex trunculus* and sea-star *Coscinasterias tenuispina* prey on mussels and during high tide thus deliberately move along the mussel bed.

Rare pea-crabs *Pinnotheres pinnotheres* and *P. pisum* are comensal species, and normally live inside alive mussels (Seed, 1971) and their occurrence, although rare, is thus not unexpected.

Epibionts - Barnacles *(Balanus* spp., *Ch. stellatus),* oysters *(O. edulis)* and polychetes with calcareous tube *(Spirorbis* sp.) settle on the mussel shells and thus colonize available "secondary space" (Dayton, 1971). Some species demonstrate gregariousness by settling closely to or directly on adults of same and/or related species. This is characteristic of barnacles and oysters (Igic, 1975). Epibiotic complex on mussels was dominated (in terms of numbers) by *B. perforatus,* especially in October, due to intensive reproduction and settling at higher temperatures. This cirriped formed colonies numbered as many as 40-60 individuals. *B. eburneus* was only sporadically observed in October, because it reproduces only in summer (Igic, 1975). Despite their dense settlement, most juvenile barnacles (base diameter to 2 mm) were dead. Igic (1975) also reported high mortality, up to 85% during the first month. It should be mentioned that the reported barnacle species (with the exception of *Ch. stellatus)* are usually not intertidal, though Barnes & Crisp (1956) reported intertidal *B. perforatus* (England), attached directly to primary substrate, rarely on mussels.

Fast-growing epibionts, e.g. ascidian *Botryllus schlosseri,* can within month completely overgrow the host-shell and impede the opening of valves, thus causing death of mussel or oyster (Igic, 1975). As far as our research of the mussel bed is concerned, the accidental ascidians succumbed to desiccation due to the periodic emersion of the infralitoral fringe.

Mobile fauna - Small gastropods find protection from external perturbations and infralitoral micro-habitat within mussel matrix. According to Jaklin (1988), the forementioned species (Table 2) e.g. *Bittium reticulatum, Alvania cimex,* carnivorous *Nassarius (=Hinia) incrassata,* are typical representatives of the soft-bottom infralitoral belt. Small crustaceans (amphipods, isopods) were numerous in mussel community at the mouth of the channel, exposed to waves.

Infaunal taxa - In the bottom layer of the accumulated sediment several species of polychetes were quite frequent if not numerous, e.g. *Perinereies cultrifera, Syllis gracilis, Nereis zonata, Cirriformia tentaculata.* Bellan-Santini (1969) also reported forementioned species in intertidal populations of *M. galloprovincialis* in the harbour of Marseille. Giangrande (1988) reported *S. gracilis, N. zonata* and *Ceratonereis costae* just below the sea surface under the cover of photophilic alga. Tsuchiya & Nishihira (1986) pointed that the occurrence and the numbers of *C. tentaculata,* a detritofagous, infralitoral species, increase with the accumulation of sediment and organic debris.

Bivalves within mussel byssal threads - large *M. galloprovincialis* (30-60 mm) completely covered the substrate and dominated the community in terms of biomass. It should be mentioned, however, that smaller mytilid species *Mytilaster minimus* (10-15 mm) outnumbered mussel several times and in most mussel beds *Mytilaster* formed dense and thick bottom layer.

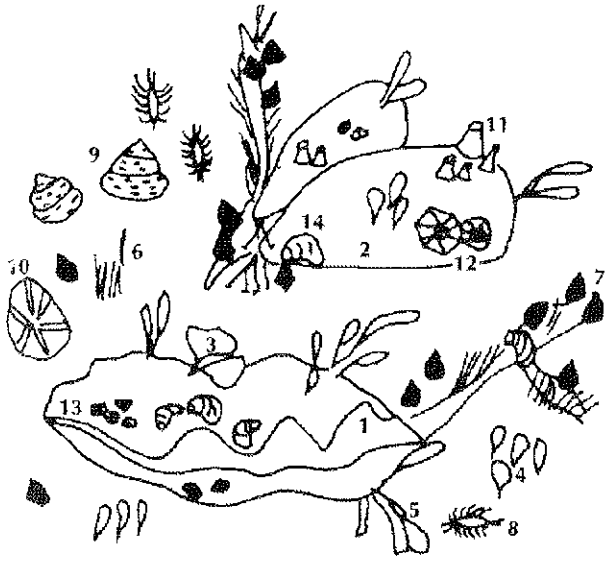

Figure 3: Intertidal community at the head of the Lim Channel.
Slika 3: Združba v bibavičnem pasu ob vhodu v Limski kanal.

1- Ostreola parenzani, 2- Mytilus galloprovincialis, 3- Ulva rigida, 4- Valonia utricularis, 5- Enteromorpha intestinalis, 6- Catenella opuntia, 7- Littorina neritoides, 8- Ligia italica, 9- Monodonta turbinata, 10- Patella caerulea, 11- Balanus perforatus, 12- B. trigonus, 13- Chthamalus stellatus, 14- Mytilaster minimus

Mytilaster (=Brachidontes) minimus usually occupies rocky intertidal belt, preferably on wave-exposed shores, and forms autonomous beds (Bouchet, 1961). Bellan-Santini (1969) reported, however, that in calm bays and harbours (slightly polluted ones) *Mytilaster* finds protection from desiccation within clumps of larger *M. galloprovincialis*. In the Lim Channel *Mytilaster* is also incorporated into mussel bed on wave-sheltered rocks (Zahtila, 1987). Although the reduced free-water supply for incorporated bivalves may cause reduction in growth the group living offers, at the same time, protection from desiccation, that is - survival in the intertidal fringe (Okamura, 1986).

Apart from *M. minimus*, the most abundant member of the associated fauna was the small (up to 3-4 mm) bivalve *Lasaea rubra* Montagu, accounting from 18 to 80% of total number of specimens. Although brooding *L. rubra* is well adapted to intertidal life, it needs certain protection from desiccation. Its presence within mussel clumps has been previously reported (Bouchet, 1961; Bellan-Santini, 1969; Lintas & Seed, 1994). Poropat (1979) reported *L. rubra* as a regular intertidal inhabitant in the Lim Channel, often among mussels. During our research somewhat uneven and patchy distribution of *L. rubra* was reported, from a few specimens to a few hundreds of specimens per sample unit. This is explained by brooding, viviparous reproduction: adult releases several already formed though smaller young directly into established population and they attach themselves within the "family" group (Morton *et al.*, 1957).

At the head of the Lim Channel fresh-water springs cause periodical decrease of surface salinity and fine mud particles settle on the rocks. Figure 3 shows detail of intertidal community with a few mussels and oysters. Tender thalii of Ulvales *(Ulva rigida, Valonia utricularis, Enteromorpha intestinalis)* also indicate lower salinity (Munda, 1977).

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POVZETEK

Avtorica obravnava nevretenčarsko makrofavno v povezavi z užitno klapavico Mytilus galloprovincialis *Lmk. v bibavičnem pasu skalnega obrežja v Limskem kanalu. V obdobju od aprila do oktobra 1994 je bilo med vzorčenjem ugotovljenih 92 vrst iz 11 debel. Po bogatosti vrst so prevladovali mehkužci (42 vrst), mnogoščetinci (21 vrst) in členonožci (12 vrst) ali 81,4% celotne združene favne. Po številčnosti so na školjčnih lupinah prevladovali vitičnjaki* Balanus perforatus *Bruguiere, med bisusnimi nitkami pa školjkice* Lasaea rubra.

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